

Trait-based approach and vulnerability analysis of soil communities affected by pesticide application

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1. Introduction

The procedures commonly used to assess ecotoxicological risks are based on the calculation of a ratio between exposure and effect indicators (usually ecotoxicological endpoints). Their value is undoubted, but they cannot predict the real consequences of a stressor for natural communities. In recent years the need of an improved ecological realism led modern ecotoxicology to move towards new tools capable to account for the complexity of ecosystems.

One of these tools is the concept of ecological vulnerability, that is now considered an essential part of site-specific risk assessment. It starts from the analysis of its three components: sensitivity, susceptibility to exposure, and recovery potential after a stress [1]. It is a stress-specific concept. The first level that reacts after a stress is the population, so that is the unit of the analysis. To upscale to the community level, population responses to stressors and inter-specific relations have to be taken into account [2].

Another recent approach is the trait-based assessment, a tool for predicting vulnerability based on the characteristics of the species. The hypothesis is that the vulnerability of species to a stressor is a function of their biological traits, such as morphology, life history, physiology and feeding ecology [3].

Though ecosystem vulnerability and trait-based assessment are two promising concepts and are used in modern ecotoxicology, especially for the soil compartment only few studies are available in the literature. This study therefore aimed at assessing the applicability of the trait-based and vulnerability analysis tools in assessing the ecological risk of pesticide use on the soil invertebrate community in an Italian vineyard.

2. Materials and methods

As the field site a vineyard in Northern Italy was chosen, under pesticide application. Three sampling points were identified: one within the field, and two “control” stations, 4 and 10m away from the last row. The sampling scheme was drawn from June 2008 to June 2009, according to the application of insecticides in the productive season and then at different intervals in order to register seasonal fluctuations of soil organisms. The microarthropod community was sampled in replicates, using a split corer of 10 cm diameter to a depth of 10 cm. The animals were extracted with Berlese or modified Tullgren-Berlese methods and kept in a preservative solution. Each organism was identified at the order level, except for ants, springtails (family level) and mites (divided into four major groups).

Morphological, life cycle, physiological and ecological traits were collected for the taxa present in the soil, to construct a big trait matrix, using information available in the literature, expert judgment or direct observations. For each trait, categories were identified and for each taxon the category was given a value. For continuous variables, the value was scaled with a range scaling. For other variables, a value between 0 and 1 was given according to the affinity of the taxon for the category.

The traits were divided into the three components of vulnerability: sensitivity, susceptibility of exposure, and recovery potential. A score (from 0 to 3) was assigned to each trait, according to its relation with vulnerability. Thus, each component of the vulnerability was quantified. These values were used as inputs in an index, used for ecosystem vulnerability [2] and here modified and applied to the soil community.

3. Results and discussion

The trait matrix was intersected with the field survey results, using multivariate statistical analysis (Principal Components Analysis, PCA). The traits linked to the most contaminated samples (among the rows or in post-application situations) were identified, and they were considered as the traits giving a minor vulnerability to the stressor in this site-specific situation. On the other hand, the characteristics linked to the less

contaminated samples (controls or pre-application and recovery situations) were considered to give a major vulnerability. The taxa more or less vulnerable were then identified according to these traits.

In an alternative approach, the vulnerability index was applied to the community and vulnerability was quantified for each taxon as a function of its traits. It is not an absolute value, but relative to the site-specific situation and the function of the traits used.

Results of the two approaches were compared. Some similarities and some differences in identifying the vulnerable or less vulnerable taxa were observed. The causes will be discussed, highlighting that the approach is based on the dimension of the trait matrix that was constructed with the available information. Unfortunately, it was difficult to find a value for each trait, thus the matrix had a lot of missing data. For the statistical analyses only those traits could be used that were available for all taxa, maybe leaving out possible important traits.

4. Conclusions

This work, for now, doesn't aim at giving an absolute result. Rather, it demonstrates a methodological approach that seems to work, though the two tools are giving different results. The approaches have yet only been applied in the water compartment (e.g. [2], [3]) and are promising perspectives for application in the soil compartment.

5. References

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